Paper title: Rapid Solidificated Aluminum Alloys based on the Water Atomized Powders
Presenting Author O.D.Neikov
Contact Email Address: neiko@mail.ru
Keywords: Aluminum-alloys
Session: Oral Session

Abstract

For aluminum and its alloys gas atomization (GA) is widely used in industry. This technology provides usually cooling rates (v) up to 10^5 K/s. The water atomization (WA) process allows to increase the cooling rate. Two main reasons restrain the application of WA process to Al alloys: high reactivity of aluminum that can cause of heavy oxidation of the surface of atomized powders and explosion danger of the atomization process due to rapid hydrogen emission us a result of the interaction with water.

This problem has been solved by using water solutions of inhibitors from the group of weak electrolytes and stabilizers of dispersions as well as their mixtures; by the control of hydrogen ion exponent and by the control of suspension temperature.

The novel rapid solidification process (WA-N) based on high-pressure water atomization of the melt for obtaining of advanced aluminum alloys was realized in the form of a pilot plant.

The pilot plant includes the following main units: high-pressure water pump, high-pressure atomizing system, induction furnace, tundish, refrigeration unit with automatic control of water and suspension temperature, hydrogen index controller, suspension vacuum filter, and vacuum dryer. The powder microstructure and surface chemistry were examined by scanning electron microscopy. The kinetics of gas emission was experimentally studied to evaluate the powder quality and to heighten the explosion security of the powder obtaining process. Tensile strength and plasticity were determined in specimens cut from the rods in the T6 condition. The ultimate tensile (UTS) and yield (YS) strengths were determined, along with the tensile elongation (EL). The melt cooling rate was calculated from dendritic parameter. The paper focuses on the discussion of key properties of powders atomized by the proposed technology.

The use of the developed processing line for production of Al alloy powders allows to improve their quality, ensure the explosion security and increase the production output.

The powder–water interaction rate strongly depends upon the value of water hydrogen index pH. At room temperature and pH = 4.0 the gas emission is practically absent. The increase of the pH value to 6.0 and higher leads to an abrupt change of the powder oxidation process under similar conditions and reaction time.

A set of PM alloys has been produced with the use of WA-N process for various applications: ultrahigh-strength Al-Zn-Mg-Cu base alloys, high-strength weldable Al-Zn-Mg base alloys and high temperature Al-Cr-Fe and Al-Fe-Cr-Ti base alloys.

The level of tensile strength with the use of WA-N process surpasses the property level of cast alloys of similar compositions. For example, the following mechanical properties at room temperature were determined for rod specimens of PM Al-Zn-Mg system with complicated TM additions in the T6 condition: UTS = 690 MPa, YS = 650 MPa, EL = 8 %. For comparison, an advanced cast alloy 1915 (in Russian classification) of the same system of 5.8(Zn+Mg)-0.5Mn-0.25Cr-0.22Zr, after thermal treatment of hot rolled profiles, has properties of UTS = 435 MPa, YS = 380 MPa, EL = 12 %.

---

my mail address: Institute for Problems of Materials Science, 3 Krzyzhanovsky Str.,Kiev, 03142, Ukraine